TEMPERATURE FORECASTING AS AN IMPLICIT FEATURE IN PROGNOSTIC CHARTS—

A Case Study for January 23–31, 1955

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1. INTRODUCTION

During the past 2 years progressively more emphasis has been placed on thickness analysis techniques in the WBAN Analysis Center. Relationships between thickness and temperature at a particular level, between thickness changes and temperature changes, and between departures of thickness from normal and departures of temperature from normal have been noted before but nothing has been published on the relationship of thickness to surface temperatures.

Thickness consistency between sea level and 500 mb. is explicitly considered in the process of preparing the prognostic charts. As a result of this definite consistency check and of independent prognostication of the thickness field the temperature field is implicit in the prognostic chart even though only isobars and contours are shown. On the other hand, thickness must be considered, either directly or indirectly, in any forecast of surface temperature. Furthermore, the correlation between thickness and free air temperatures is indisputedly high because thickness is a direct measure of the air mass temperature. Therefore it remains to determine the degree to which this correlation is applicable in practice to surface temperature forecasting.

It has been observed that a very good computation of the surface minimum temperature can be obtained occasionally by using the departure of 1000–500-mb. thickness from normal. This follows from the hydrostatic relation that a 5.4° F. change [1] in the mean virtual temperature of the layer between 1000 mb. and 500 mb. requires a 200-ft. change in thickness of the layer. A consideration of the converse relationship leads to the plausible conclusion that under favorable conditions every 200-ft. change in thickness requires a 5.4° F. change in surface temperature. The easiest way to apply this type of reasoning seemed to be from the standpoint of temperature and thickness normals. It was therefore considered worthwhile to run a test of a series of synoptic charts rather than a statistical analysis of the data.

In the present article a series of departure from normal thickness charts is presented for comparison with departure from normal of minimum and maximum surface temperatures for the period January 23–31, 1955 (figs. 1–6).

2. DESCRIPTION OF CHARTS

The charts of departure from normal thickness were copied directly from the operational charts of the WBAN Analysis Center. These charts are used regularly by the prognostic analysts in the Analysis Center. The prognostic departure from normal thickness charts were prepared by using the surface prognostic chart and the 500-mb. prognostic chart. A 1000-mb. prognostic was made from the surface prognostic by simple interpolation in the same way that the 1000-mb. analysis is made twice daily from the 0330 GMT and the 1530 GMT surface charts. Table 1 gives the conversion values used in the interpolation. A prognostic thickness chart was then prepared by subtracting the prognostic 1000-mb. chart graphically from the prognostic 500-mb. chart.

The departure from normal minimum and maximum temperature charts were prepared from the minimum and maximum temperatures transmitted with the 1230 GMT and 0030 GMT data respectively. A minimum temperature chart and a maximum temperature chart were analyzed for each day and from each of these charts the respective normal chart was subtracted. Thus the departure from normal minimum temperature was obtained by subtract-

TABLE 1.—*Interpolation values for isobars on the mean sea level analysis to obtain the contours on the 1000-mb. analysis* [2]

1000-mb. height	Surface temperature of			
	<0° F.	0°–35° F.	35°–70° F.	>70° F.
−1000	959.0	961.5	963.5	966.0
−800	967.0	969.0	970.5	972.5
−600	975.0	976.5	978.0	979.5
−400	983.0	984.0	985.0	986.0
−200	991.5	992.0	992.5	993.0
0	1000.0	1000.0	1000.0	1000.0
+200	1008.5	1008.0	1007.5	1007.0
+400	1017.0	1016.0	1015.0	1014.0
+600	1025.0	1024.0	1022.5	1021.0
+800	1033.5	1032.0	1030.0	1028.0
+1000	1042.0	1040.0	1037.5	1035.5

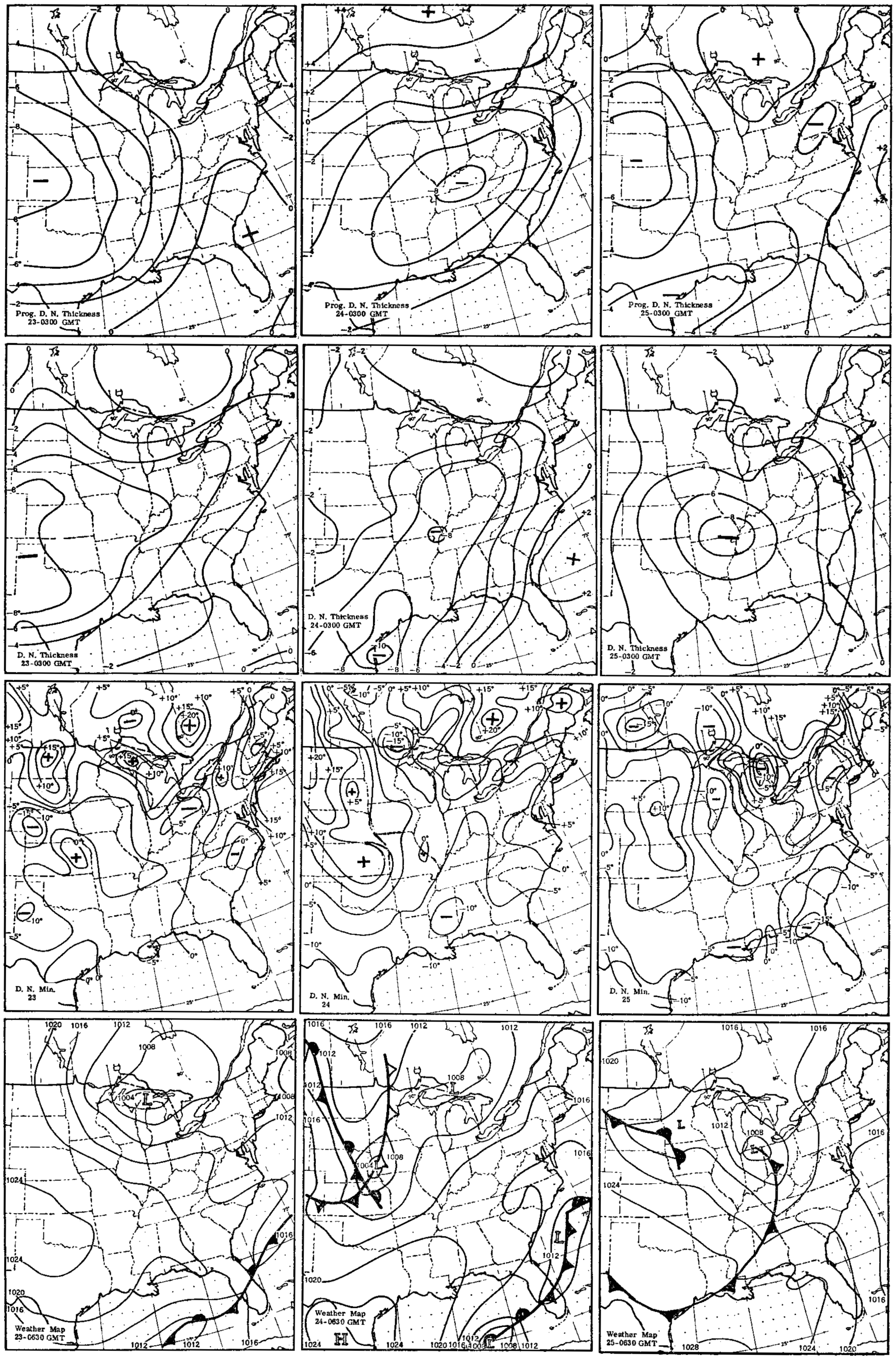

FIGURE 1.—Charts for January 23, 24, and 25, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 0300 GMT, the departure of minimum temperature from normal for the day, and the sea level weather map for 0630 GMT.

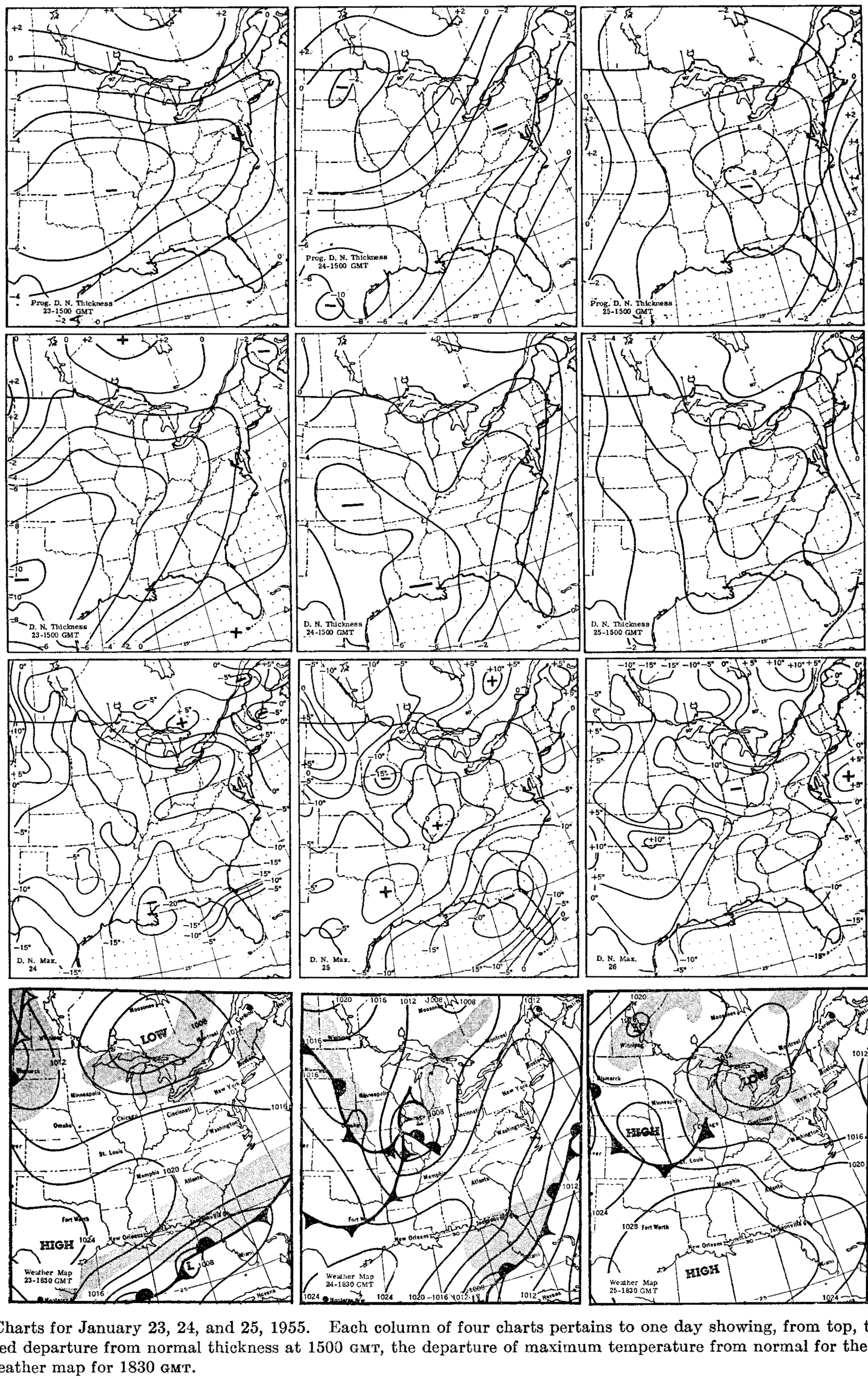

FIGURE 2.—Charts for January 23, 24, and 25, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 1500 GMT, the departure of maximum temperature from normal for the day, and the sea level weather map for 1830 GMT.

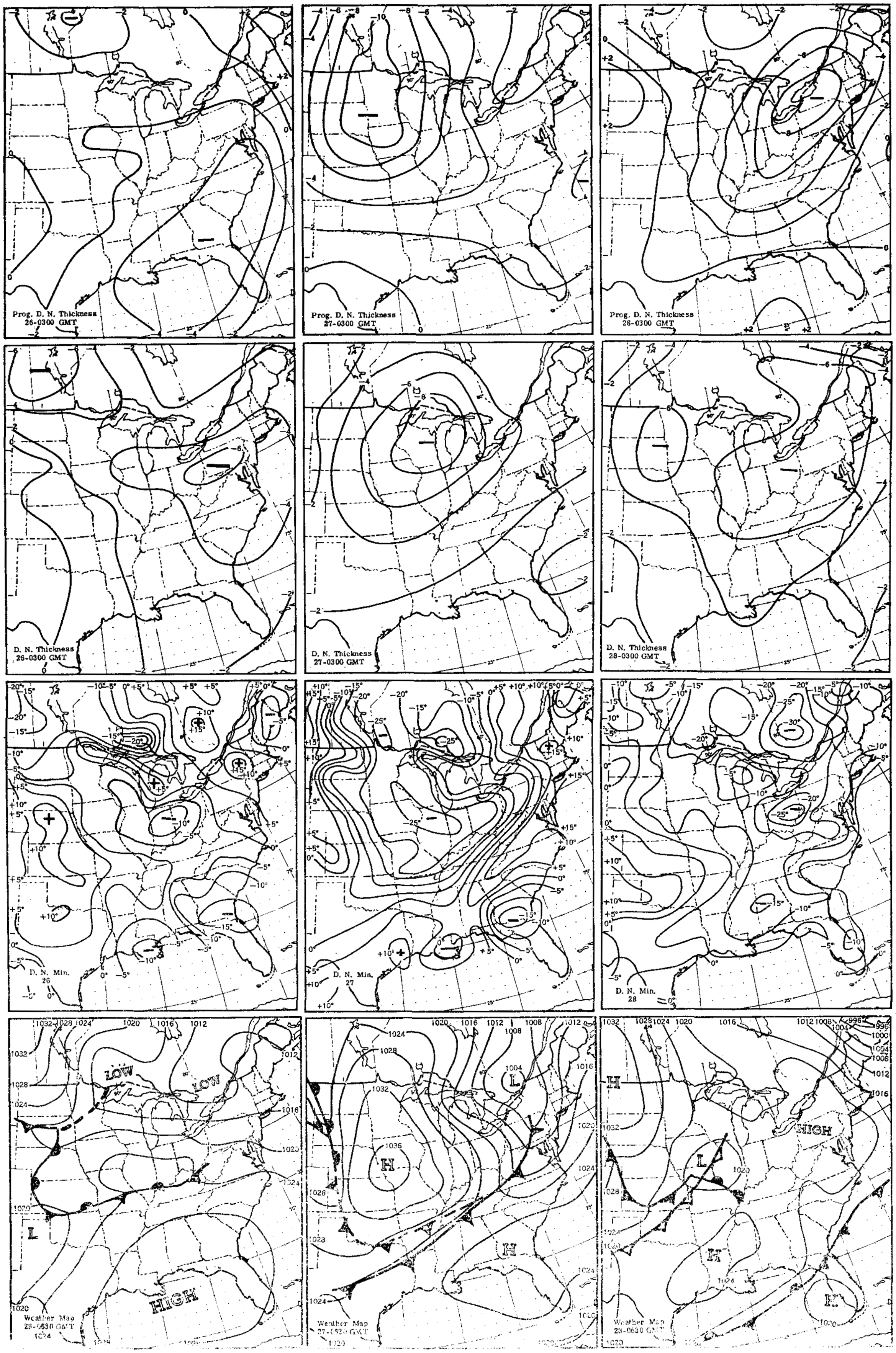

FIGURE 3.—Charts for January 26, 27, and 28, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 0300 GMT, the departure of minimum temperature from normal for the day, and the sea level weather map for 0630 GMT.

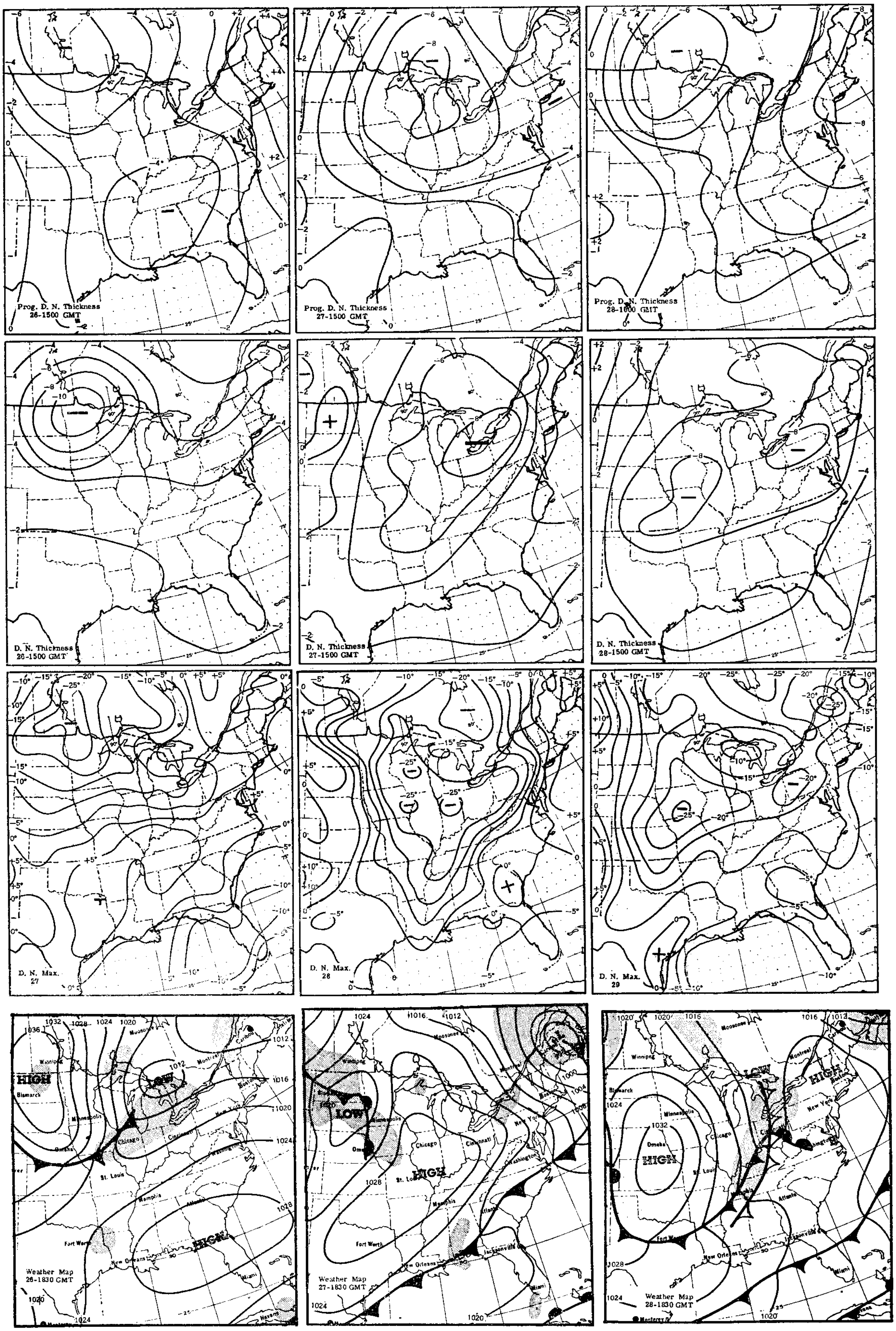

FIGURE 4.—Charts for January 26, 27, and 28, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 1500 GMT, the departure of maximum temperature from normal for the day, and the sea level weather map for 1830 GMT.

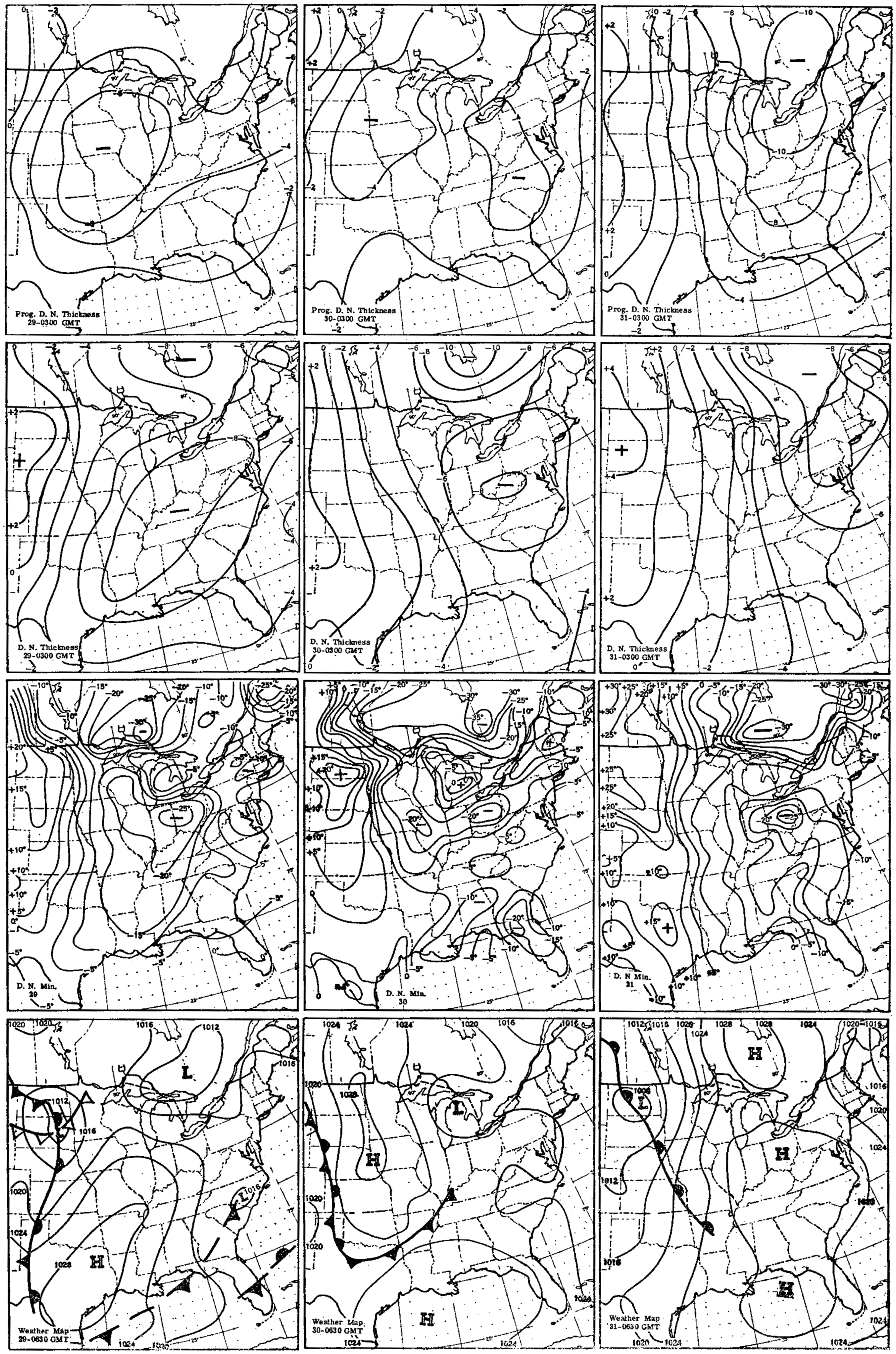

FIGURE 5.—Charts for January 29, 30, and 31, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 0300 GMT, the departure of minimum temperature from normal for the day, and the sea level weather map for 0630 GMT.

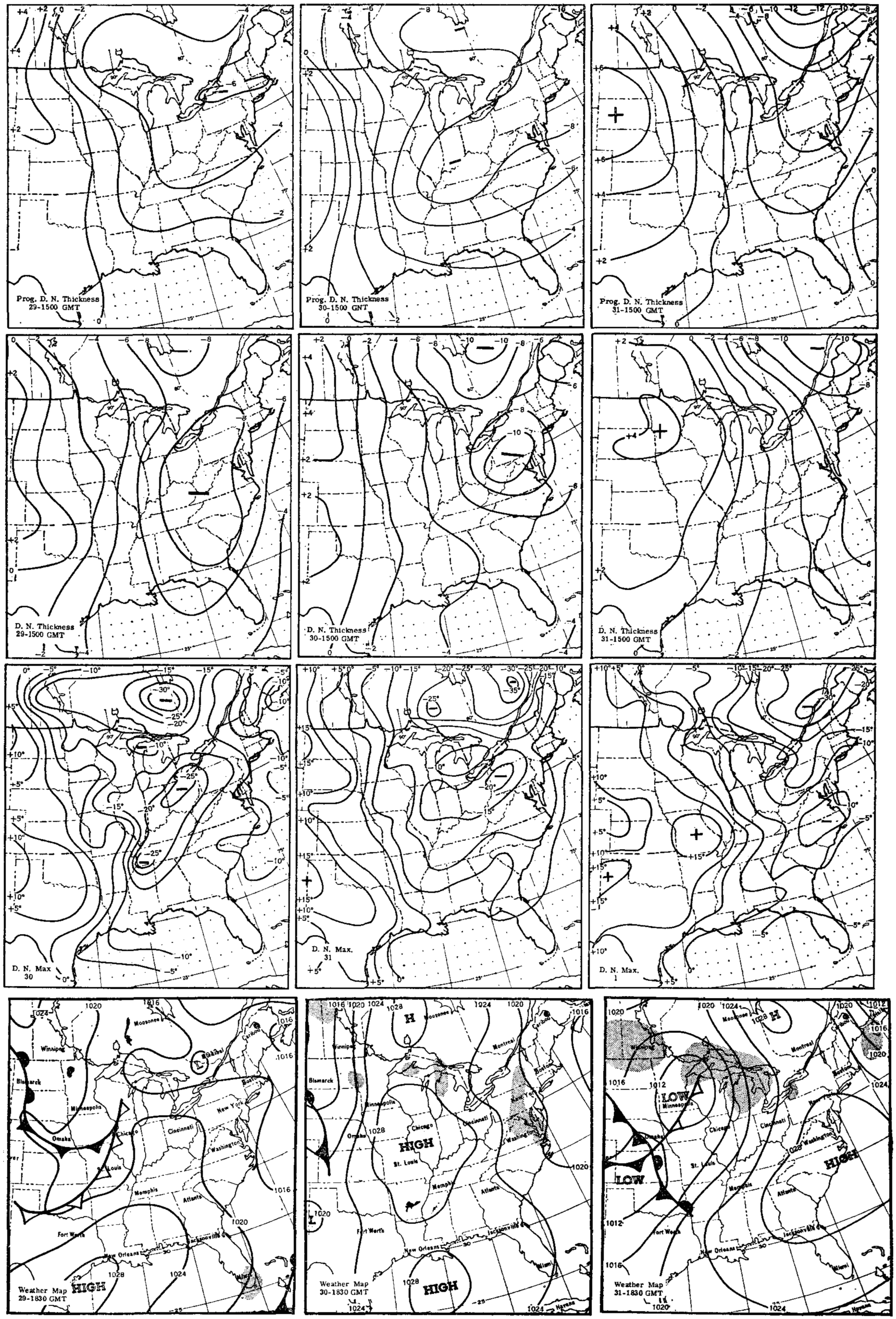

FIGURE 6.—Charts for January 29, 30, and 31, 1955. Each column of four charts pertains to one day showing, from top, the prognostic and observed departure from normal thickness at 1500 GMT, the departure of maximum temperature from normal for the day, and the sea level weather map for 1830 GMT.

ing graphically the normal minimum temperature chart from the observed minimum temperature chart. A similar procedure was followed to obtain the departure from normal maximum temperature chart.

The normals of maximum and minimum temperatures for the United States were taken directly from the charts printed on the back of the *Daily Weather Map* [3]. The normals for Canada were obtained from official publications of the meteorological service of Canada [4].

The maximum temperature is reported for the 12-hour period preceding 0030 GMT and the minimum temperature is reported for the 12-hour period preceding 1230 GMT. Thus the departure from normal thickness for 1500 GMT falls within the period for which the maximum temperature is reported; and the departure from normal thickness for 0300 GMT falls within the period for which the minimum temperature is reported. Since the maximum temperature on any day will be contained in the report for 0030 GMT under the date of the *following day*, the charts of departure from normal of maximum temperature carry a date line for one day later, respectively, than the others.

3. DISCUSSION OF CHARTS

Since minimum and maximum temperatures are so often affected by local factors, a strictly quantitative relation will not hold between the departures from normal of thickness and those of daily temperature extremes. However, *areas* of departure of thickness from normal should be closely related to the *areas* of departure of minimum and maximum temperatures from normal. This is especially true where a fresh outbreak of cold air is moving into an area; that is, when conditions are such that the dominating influence is the temperature of the air mass, rather than incidental factors such as cloudiness, precipitation, and radiation. This occurs usually with good air movement (10 to 20 knots) with or without clouds so long as they are air mass clouds and not warm clouds above a frontal inversion. The local forecaster is acquainted with, and is thus able to apply, the corrections for local factors affecting temperature readings better than the prognostic analyst in the central analysis center who is concerned with the relatively large scale changes.

The average maximum and minimum temperatures [3] show the effect of the Great Lakes by the distortion of the isotherms northward over the Lakes. However, the departure from normal temperature charts, figures 1 to 6, show very pronounced patterns and large departures on most of these 9 days. This is due to the fact that the air was very cold and therefore the warming effect of the Lakes was at a maximum.

The best correlation during the period of study occurred with fresh outbreaks of cold air when the departure from normal thickness was at a maximum between the surface High and Low. Poorest correlation occurred when departures from normal were due to radiation (with light winds and clear skies).

The charts for the 23d and 24th of the month (figs. 1 and 2) are the least impressive insofar as agreement between the departure from normal thickness and the departure from normal of the maximum and minimum temperatures are concerned. Beginning with the 25th the departures began to show better correlation both with regard to pattern and with regard to quantity. The charts for the 25th and 26th in the maximum temperature group (figs. 2 and 4) show good agreement except in the southern portion on the 26th. In the series of charts related to both maximum and minimum temperatures those for the 27th through the 31st seem to be better than the others (figs. 3–6).

REFERENCES

1. D. Brunt, *Physical and Dynamical Meteorology*, Cambridge University Press, London, 1934, p. 3, eq. (16).
2. R. J. List (Ed.) *Smithsonian Meteorological Tables*, 6th ed., Washington, D. C. 1951, Table 57, p. 257.
3. U. S. Weather Bureau, *Daily Weather Map*, Washington, D. C., Dec. 17, 1954.
4. Meteorological Division, Dept. of Transport, *Climatic Summaries for Selected Meteorological Stations in the Dominion of Canada*, vol. 1, Toronto, Canada, 1947, and Addendum, 1954.